REPORT

OF

WESTERN PINE BEETLE SURVEY.

HAPPY CAMP - LAVA BED AREA

MODOC NATIONAL FOREST

October 1926

By

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SUMMARY

1. The Modoc-Lava Bed area lies in the northwest corner of Modoc County in northern California.

2. It comprises 435,000 acres of timber land of which 44% is in the Modoc National Forest and the rest in private ownership. Most of the private timberland is owned by the Red River Lumber Company and the Pickering Lumber Company. The timber stand is estimated to exceed 6 billion feet.

3. The present insect survey is the fifth annual survey which has been made of the area by the Bureau of Entomology and Forest Service in cooperation with the private owners.

4. The percent of stand killed since 1921 has varied as follows:

1921 - .92%
1922 - .75%
1923 - .40%
1924 - .96%
1925 - 1.09%
1926 - 2.10% (predicted loss)

Epidemic conditions existed in 1921, but decreased to an endemic status in 1923. Following the dry winter of 1923-24 an increase occurred and continued up to the present time.

5. The present infestation was as high as 5% of the stand on the northern edge of the Glass Mountain Unit; 3% through the heavy timber stands of the Happy Camp Unit and 2% through the Badger Unit.

Strip counts on the Glass Mountain Unit showed that on limited areas 25% of all trees over 6" in diameter and 35% of all trees over 24" d.b.h. had been killed by beetles in the last five years.

The scattered timber stands of the lava bed unit showed a light beetle loss.

6. The western pine beetle, the pine flathead borer, and the mountain pine beetles are the direct agencies responsible for the death of the trees.

The underlying causative factors are insufficient moisture for normal tree growth, and the effects of recent fires. Moisture deficiency is due to subnormal precipitation, porous soils and the demands of a dense understory of reproduction and brush.

7. Three courses of action are open in dealing with this situation:

(1) To allow the infestation to run its course.
(2) To log the area and salvage the timber.
(3) To apply artificial control methods.

TABLE I

Estimated Beetle Losses For 1925

Unit	Acres	Stand M.B.M.	Killed in 1925 Trees	Killed in 1925 Volume (M.B.M.)	Killed in 1925 %Stand
1. - Glass Mountain	68,860	1,214,300	18,650	14,680	1.21%
2. - Timber Mountain	2,600	22,000	1,300	1,170	5.32%
3. - Badger	67,760	818,460	13,130	12,240	1.50%
4. - Lava	73,200	631,300	7,000	9,250	1.46%
5. - Happy Camp	68,660	1,298,840	11,070	11,280	.87%
6. - Pit River	35,200	310,140	4,070	3,120	1.00%
7. - White Horse	60,800	1,337,720	7,730	10,940	.82%
8. - Big Valley Mountain	46,400	508,000	3,460	3,960	.78%
9. - Hot Springs	11,520	101,700	2,140	1,710	1.68%
Total	435,000	6,242,460	68,550	68,350	1.09%

Total predicted loss for 1926 130,000 trees 130,000 M.B.M. 2.10%

PREFACE

Heavy insect losses on the Lava Bed area of the Modoc National Forest were first brought to the attention of the owners in the fall of 1922. In November of that year Mr. A.J. Jaenicke, Forest Examiner of District 6, made an examination of the area and reported a very heavy increase in beetle activity during the years 1920 to 1922 (Report December 1922.)

Mr. Jaenicke's examination was followed in the fall of 1923 by a 7.4% cruise of the area made by a two man crew under the direction of the writer. This cruise was covered in a report of October 20, 1923, in which the control considerations were discussed and the cost of applying control on certain areas estimated.

Another survey was made in the fall of 1924 under the direction of the writer and the progress of the infestation determined. (Report of November 1924.)

In the fall of 1925, Mr. Patterson made a survey of the area and reported (October 1925) the conditions on the area at that time.

At the request of the District Forester, of District 5, the fifth annual pine beetle survey of the Modoc Lava Bed area was made by F.P. Keen, Associate Entomologist and W. J. Buckhorn, Assistant Scientific Aid of the Bureau of Entomology from September 10 to October 10, 1926. This survey is covered in this report.

Fourteen check plots of 320 acres each, selected in previous years as typical of the various forest types, were again cruised this year and the trees, killed during 1925 and the summer of 1926, blazed, numbered serially, and recorded. In addition, sample strips were run throughout other portions of the forest and the trees recently killed by beetles were counted. These data, together with information or growth, volume of stand, timber types etc., furnished by the Forest Service, form the basis for the estimates of total beetle loss, and percent of stand killed. The area covered was too large to permit the securing of detailed data on losses for any individual section or ownership other than on the check plots; instead the effort was made to secure a picture of the general beetle situation throughout the area and some insight into the causes and possible future developments.

By agreement, the Forest Service paid the salaries and furnished the field equipment and transportation. The total cost of the survey was as follows:

Field expenses (Forest Service) . .	$ 167.61
Salaries (Bureau of Entomology) . .	375.00
Total	$ 542.61

MODOC LAVA BED AREA

Description.

The Modoc Lava Bed Project is in the northwestern corner of Modoc County, California, and comprises the Happy Camp District of the Modoc National Forest and the adjacent and intermingled private lands.

On the north, the area is bounded by the open sage brush and lava bed lands of the Tule Lake region. On the east, is an open scattering stand of juniper. To the south the Pit River with its adjacent open valley lands and the large farming district of Big Valley forms the boundary. On the west, the area is for the most part bounded by the barren lava and glass flows of Glass Mountain but connects at a few points with the timbered area of the Shasta National Forest. The Widow Valley, Muck Valley, and Hot Springs Units which have been included in previous surveys really form no part of the Lava Bed Area but represent an entirely distinct timbered belt with a different flora and different conditions of infestation. Although they were again estimated in this year's survey, it is suggested that they be eliminated from future examinations of the Lava Bed Area.

The topography of the Lava Bed Area is that of a high plateau, nearly flat with no well defined drainage, and through the lava beds proper the ground is broken by a series of lava hummucks and reefs, with pockets of soil in which the timber seems to find plenty of moisture. The general level is about 4,600 feet but is broken by a few peaks such as Timber Mountain and Happy Camp Peak which rise to elevations over 6,000 feet.

The soil on which the best timber growth occurs is a reddish sandy loam formed from decomposed lava rock over which it lies. Through the lava beds the soil is a fine powdery decomposed lava ash. On the Glass Mountain Unit a yellow lava ash forms the subsoil and is overlaid from a few inches to several feet in thickness with a gray coarse pumice.

Through the pumice soils bitter brush forms nearly the only ground cover. Yellow pine reproduction here is not heavy and over much of the area is entirely lacking. However, in some places a very heavy crop of seedlings is now on the ground and if fires are kept out a very dense stand of reproduction will form in a few years.

Over the lava beds the ground cover is sparse and consists of a mixture of sage, snowbrush, manzanita, wild plum, squaw mat, mountain mahogany, bitter brush and cheat grass, with a scattering of yellow pine reproduction.

On the red soils especially in the Egg Lake district, the ground is covered with a very dense stand of yellow pine reproduction, with only a scattering of manzanita, bitter brush and mountain mahogany.

According to height classification most of the timber on the area falls into Site IV. A few localities will run to Site III and some of the very best, especially in the White Horse Unit, will probably fall in Site II. A high percentage of the timber is mature and growing very slowly. Wherever the stand has been opened up a fairly good rate of growth is attained.

Timber Resources and Ownership.

The total timbered acreage of the area including the Big Valley Mountain and Hot Springs Units is approximately 435,000 acres, and carries a stand of timber estimated at six billion feet.

Of this area, 345,760 acres (excluding the Big Valley and Hot Springs Units) have recently been covered by a Forest Service timber reconnaissance under the direction of Mr. O.M. Evans. The report of this reconnaissance (March 5, 1926) gives the total merchantable stand at 5,525,538 M.B.M. of which about 55% is owned by the Red River Lumber Company; 19% by the Pickering Lumber Company and the remainder under government ownership. The government timber is estimated to run 11 M per acre, the Red River Lumber Company's timber 21 M per acre; the Pickering timber 15 M per acre and the timber of small patented tracts 4.5 M per acre. Of the total stand 90% is western yellow pine, the remainder a mixture of sugar pine, white fir and incense cedar.

Past Infestation.

The surveys of the past five years show that the area suffered from an epidemic of beetles during 1920 to 1922. In 1923, the infestation decreased to almost an endemic condition. Then following the dry winter of 1923-24 an increase in the infestation commenced and continued during 1925 and 1926. During 1923, the total loss estimated at about 20,000,000 board feet represented .4% of the stand or a loss which was easily offset by normal growth. In 1924, the loss increased to 35,000,000 feet or .7% of the stand. The present survey shows that the loss for 1925 amounted to 68 million board feet or 1.09% of the stand.

Present Infestation.

The present infestation is by far the heaviest that has occurred since the area has been under observation. The total estimated loss for the year 1926 of 125 million board feet represents 2% of the stand.

Through some of the best timbered sections of the Red River Lumber Company the year's loss amounts to 3% of the stand, a loss which is not offset by growth and represents a real depletion in the forest capital.

The heaviest losses for the year occur on the northern portion of the Glass Mountain Unit on government land and the lands of the Pickering Lumber Company. For several square miles 25% of the timber over 6 inches in diameter has been killed in the last few years and the loss for the present year will average nearly 5% of the stand. Fortunately, this condition does not exist over any large areas.

Through the lava beds, although the timber is scattered, the timber is growing thriftily and the beetle loss is light.

Due to difference in soil and growth conditions the forest naturally divides itself into several entomological units. The conditions on the various units are covered in the following discussion. (In one or two cases the unit boundaries have been changed to more nearly conform with the topography, the natural timber and soil conditions.)

GLASS MOUNTAIN UNIT.

Description.

The Glass Mountain Unit lies in the Northwest corner of the Happy Camp Area. It comprises 68,860 acres of forest of which 84% is in private ownership and 16% in the Modoc National Forest.

From the lower elevations on the east and north the land gradually rises to the west ascending the eastern slope of the Glass Mountain range. At the lower elevations the timber scatters out over the lava beds where it is mixed with juniper. Here the tree growth is slow and the timber has to struggle for its existance with unfavorable soil and moisture conditions. As the land rises the quality and thrift of the stand improves until at the upper levels it becomes mixed with fir and lodgepole.

The soil for the most part consists of a light gravelly pumice from one to two feet in thickness overlaying a yellow loam subsoil from which the trees derive practically all of their moisture.

A uniform growth of bitter brush, about two feet in height comprises practically the only ground cover. Yellow pine reproduction is sparse and occurs in groups between the openings of the larger trees. No recent severe fires have occurred on the unit, the sparseness of the ground cover being unfavorable to heavy burns. On the average, the timber is of fair quality running to Site III and IV and averaging about 15 M board feet per acre.

Past Infestation.

At least for the past five years the beetle losses have been extremely heavy in the poorer quality timber along the northern and eastern edges of the unit.

A five chain strip a mile in length through the typical heavy infestation of the northern edge in which all live and dead trees were counted showed that during the past five years 25% of all trees over 6" d.b.h and 35% of all trees over 24" d.b.h. had been killed by the beetles.

Starting with a fairly heavy loss in 1921 the infestation declined to a low point in 1923. Then commencing with the dry year of 1924, the infestation increased three times over that of the previous year. In 1925, this increase in infestation continued and the check section showed a loss of 340 trees averaging 1,000 bd. ft. per tree for the year.

Present Infestation.

With the continuation of dry years from 1924 to 1926 the infestation increased by leaps and bounds. On the check section, the summer loss for 1926 occurred in groups and reached the total of 140 trees on the half section or 280 trees for the full section.

One noticeable feature of this infestation was the high percentage of trees killed by flathead borers.

On N ½ of Sec. 36 - T 44 N R 5 E.	No. of trees killed during summer of 1926.	No. trees killed during 1925.	
Killed by western pine beetle	115	112	66%
Killed by pine flathead borer	21	44	26%
Killed by mountain pine beetle	4	13	7%
Killed by unknown cause		1	1%
	140	170	

Such an unusually large proportion of flathead killed trees would indicate that the primary cause of the infestation was drought, since the flathead beetles show a great preference for trees on dry sites and suffering from lack of moisture.

The present infestation is not uniformily scattered through the unit, but varies according to the elevation. The heaviest losses occur on the lower slopes where, because of the dry years, conditions have become temporarily unfavorable for pine growth. As the elevation increases up the slope of Glass Mountain the infestation decreases so that at about 5,500 feet only an endemic infestation is found.

Cause of the Epidemic Conditions.

The recent beetle epidemic has undoubtedly been the result of the recent abnormal weather and moisture conditions.

The stand of timber has a high percentage of overmature trees. The pumice soil is very low in water holding capacity. During drought years, there are more trees demanding moisture than the soil can supply. As a result, the trees wilt and their growth stops. This furnishes an ideal set of conditions for the development of beetle broods. And in this case they have made the most of their opportunity.

TIMBER MOUNTAIN UNIT.

Description.

This unit comprises 2,600 acres of yellow pine forest lying on the slopes of Timber Mountain which rises about 600 feet above the general level of the lava plateau in the northern part of the area.

Sage brush, juniper and open grass lands completely encircle the mountain so that the timber is separated from the nearest adjacent stands by a mile or more.

The soil is a yellow loam over lava rock.

The timber on the southern exposure is very scattered but on the north slope grows in a denser stand. Here the ground is covered with a heavy growth of bitter brush, mountain mahogany, manzanita, and yellow pine reproduction.

A fire which occurred on the 4th of July 1924 swept over the eastern half of the mountain and killed about 50% of the stand.

Past Infestation.

The infestation on this mountain has been fairly heavy for some time. The 1922 loss was estimated as averaging about 100 M.B.M. per section. The 1923 loss was considerably less than this, but increased again during 1924, 1925, and 1926.

The Timber Mountain Burn.

The fire which swept over the eastern end of Timber Mountain covered about 1,000 acres of timber and brush lands. Although the fire did not crown throughout the entire area the humidity was low and the heat so intense that a great many trees with their needles only partly burned died as a result of the fire.

During 1925 and 1926 a great many of these fire-weakened trees succumbed to the attacks of insects thus augmenting the fire loss.

Cores taken from the green fire scorched trees showed a great slowing down in their growth during 1925 and 1926. The reduction in growth was about proportional to the reduction in leaf surface. Trees with all the foliage killed and not attacked by insects still had fresh living cambium but no growth had taken place since the fire.

A strip 10 chains in width and two miles in length through the burned area and adjacent unburned area showed an average yearly loss for 1925 and 1926, of:

300 trees killed by insects per section on unburned area.
1120 " " " " " " " " burned area.

Thus nearly four times as many scorched trees with their slower growth were killed by insects as trees in the adjacent virgin forest.

Causes of Epidemic Conditions.

The effect of the burn in retarding the growth and weakening of the trees, together with deficient moisture conditions are probably the two most important factors in causing the high beetle loss on this unit.

BADGER UNIT.

Description.

This unit takes in 67,760 acres in the northeast portion of the Happy Camp area of which one solid township is national forest land.

The topography is nearly flat to gently rolling with no well defined slope or drainage.

The soil is a red sandy loam formed by the decomposition of lava rock. Numerous outcropping of lava occur throughout the area.

The ground is lightly covered with bitter brush, squaw mat, manzanita, small patches of yellow pine reproduction, a scattering of juniper trees and a little mountain mahogany. The area has been fairly heavily grazed by sheep and horses so that in no place is the brush dense.

The timber is fair quality belonging for the most part to Site IV and averaging about 13 M.B.M. per acre.

Past Infestation.

In recent years the heaviest beetle loss occurred in 1921. For that year the check section showed a loss of 170 trees or 135 M.B.M. After 1921 the infestation showed a steady decline until 1923 when the low point was reached. On the check section for that year only 47 trees were killed by the beetles. Following the very dry winter of 1923-24 the infestation commenced to increase. The summer generation trees of 1924 had light broods but the winter broods were fairly heavy. As yet the infestation showed no tendency to occur in groups. The loss during 1925 continued to increase; about 100 trees were killed on the check section.

Present Infestation.

Starting with the summer generations of 1926 the infestation commenced to occur in groups. Numerous groups of from 7 to 11 large trees were found throughout the unit. The check sections showed a loss of over 100 summer generation trees with indications that the winter generation would bring the yearly loss to over 200 trees. Thus the present infestation is the heaviest of which we have record.

Cause of Epidemic Conditions.

The recent dry years are undoubtedly responsible for this increase in beetle losses. The resistence of the trees have been lowered by lack of sufficient moisture, so that they have become an easy prey to the beetles. This conclusion is supported by the fact that the increase in infestation followed immediately after the dry winter of 1923-24 and has continued during the subsequent dry years.

LAVA UNIT.

Description.

This unit comprises 73,200 acres of timbered lava bed country on the west side of the Happy Camp district and separating the Happy Camp and Badger Units from the Glass Mountain Unit. The unit is nearly flat with no particular drainage and consists of rough lava hummocks and ridges with intervening depressions filled with a little loose, powdery, yellow, pumice soil.

Because of the rocky outcroppings, the timber is sparse and scattered but appears to be growing thriftily since the trees have very little competition with their neighbors.

The ground cover consists of scattering patches of sage brush, snow-brush, manzanita, wild plum, squaw mat, mountain mahogany, bitter brush, cheat grass and a scattering of yellow pine reproductions and incense cedar.

Past Infestation.

Because of the scattered stands and the rapid individual growth of the trees, the infestation on this unit has always been considered as endemic, since only a few trees are killed to each square mile. A strip 5 chains wide and a mile long was run through a typical section of this unit and all live trees and those killed during the past five years were counted. This showed a loss of 10% of all timber over 6" in diameter as a result of beetle work. The highest percentage of loss occurred in trees over 28 inches in diameter - 33% of such trees having been killed.

Present Infestation.

A typical 320 acres of timber was cruised and the 1925 and 1926 loss marked. This showed 25 trees killed in 1925 on the half section and 24 trees killed by the summer generation of 1926. Thus while the area would be considered as endemic in 1925 large groups of newly killed trees would put the area in the epidemic class.

Causes of Epidemic Conditions.

The recent dry years are without question responsible for the sudden increase in the infestation. A year of normal rainfall and normal growth would soon put this unit back in the endemic class. For this reason and also because of the low value of the timber on this unit no artificial control work would be warranted.

HAPPY CAMP UNIT.

Description.

The Happy Camp Unit lies in the center of the Happy Camp area and contains some of the best timber to be found on the area. The 68,660 acres of forest land within the boundaries are 22% in government and 78% in private ownership.

The topography is gently rolling to nearly flat with a gradual slope towards the west. The soil is the red sandy loam overlying lava rock which appears to be one of the best timber growing soils in southern Oregon and northern California.

Though most of the area fires have been kept out for the past twenty years and the ground is densely covered with yellow pine reproduction from a few inches to 10 feet in height. In addition to the yellow pine reproduction there is a scattering of white fir, incense cedar, bitter brush, manzanita and mountain mahogany.

The timber is of good quality and the stand is fairly heavy. The trees are dark green in color with long needles and show thrifty growth wherever they are not too densely crowded.

Past Infestation.

Throughout the unit there are evidences of old beetle killings, but no evidence of very heavy losses. Since the surveys started in 1921 the unit has been either moderately epidemic or endemic.

The low point in the recent infestations was reached in 1923. In 1924, there was a very heavy increase and the beetle killed trees started to appear in groups. The 1925 loss continued to increase over that of 1924 and the groups became larger.

Present Infestation.

The present infestation (that of 1926) is the heaviest which has occurred in recent years and next to the northern part of the Glass Mountain Unit is the heaviest infestation on the Lava Bed Area.

On 320 acres of the check section 125 trees were killed during the summer of 1926 and the indications were that the winter brood would be even heavier. At this rate, the 1926 infestation through the best timber stands would run as high as 500 trees or approximately 500,000 board feet killed per square mile. This infestation occurred in groups and groups of from 17 to 32 trees were not uncommon.

Causes of Epidemic Conditions.

The increase of infestation on this unit as well as on other portions of the area has undoubtedly been brought about by the drought conditions of recent years. On this unit the water competition of the trees has been further aggravated by the moisture requirements of the dense stand of reproduction. As a result, large trees growing closely together have been unable to secure sufficient moisture and have therefore become easy victims for the bark beetles.

With the killing of this large quantity of timber moisture competition will be reduced for those that survive and a new natural balance will be restored.

PIT RIVER UNIT.

Description.

This unit lies on the eastern edge of the Happy Camp area south of the Badger Springs unit and east of the Happy Camp Unit. It comprises 35,200 acres of land of which 71% is in the Modoc National Forest and the rest in private ownership.

The country is nearly flat except where it breaks off to the east and south into the Pit River, otherwise it is only broken with small rolling hills and ridges. The general drainage is to the southeast. The soil for the most part is a yellowish brown loam shallowly overlying the lava rock which breaks through on the ridges.

The ground is covered with a scattering growth of bitter brush, mountain mahogany, with a little juniper and scattering patches of dense yellow pine reproduction. The timber is for the most part of fair quality but the stand is not heavy since it is broken with large barren flats and meadows. Due to the scattered growth the individual trees do not suffer from competition and are for the most part growing thriftily.

Past Infestation.

Previous surveys have listed this unit as heavily epidemic in certain portions, and evidence of this loss is still present in the form of groups of snags and ghost trees.

Present Infestation.

Possibly due to the fact that the unit has been epidemic for several years and a considerable percentage of the stand and the susceptible trees destroyed the general increase in infestation for 1925 and 1926 did not occur on this unit and the unit at the present time appears to be comparatively clean.

Since the endemic year of 1923 the check section has shown losses as follows:

Estimated Loss per check section.

1923	74 trees
1924	94 "
1925	83 "
1926	82 "

The largest group of trees killed by the winter generation of 1925 consisted of 13 trees from 10 to 24 inches in diameter. Most of the groups consisted of from three to five trees.

The grouping of summer trees of 1926 was not as noticeable on this unit as on other units. The largest group on the check section sonsisted of 6 trees from 14 to 36 inches in diameter.

WHITE HORSE UNIT.

Description.

This unit lies in the southwestern portion of the Lava Bed area. The 60,800 acres of forest land are for the most part in private ownership. The summit of the Big Valley mountain range forms the southern boundary of the unit, so that most of the unit lies on the northern slope of this range and extends out to the flat lava bed country.

The soil consists of red sandy loam covering the lava rock to considerable depth.

The forest floor is covered with a fairly heavy growth of brush of which snow brush predominates, squaw mat, huckleberry, snow berry and manzanita are also fouhd.

Western yellow pine reproduction is fairly heavy throughout the area, and is mixed with white fir, sugar pine, and incense cedar.

The timber is of good quality and consists of an excellent stand of western yellow pine of Site II, mixed with white fir, sugar pine and some incense cedar. The trees are for the most part mature, tall trees with dark green foliage and long thrifty needles.

Past Infestation.

While from time to time groups of trees have been killed by the beetle, the evidence on the ground indicates that this unit has not suffered from any recent heavy epidemics. Since the first of these surveys in 1922 the loss has been classed as a moderately high or moderate epidemic. In 1924 this unit showed a heavy increase in infestation and again increased in 1925.

Present Infestation.

While the infestation continued to increase in 1926, still it did not develop a heavy epidemic like other units on the area, except in the northwestern corner where a very heavy loss occurred.

The check section showed the following increases:

Year.	Trees killed per section.
1923	58
1924	111
1925	124
1926	135 (tentative)

Taking the unit as a whole it is estimated that 19 million board feet of timber will be killed by the beetle attacks of 1926 which will represent a loss of 1.5% of the stand.

BIG VALLEY MOUNTAIN UNIT.

Description.

This unit, which includes the two units formerly called the Widow Valley and Muck Valley Units, takes in the eastern and southern slopes of the Big Valley mountains from the summit of the range lying south of White Horse and Kramer reservoirs south to the Pit river. On the east it is bounded by the open farming land of Big Valley and on the west by the untimbered brush slopes which extend along the western slope of the range.

The unit is rough and mountainous with very little level land. The drainage is toward both the east and west.

The soil is a reddish sandy loam covering the underlying lava rock to considerable depth except on the top of the ridges.

The ground cover consists of a heavy growth of brush and reproduction consisting of snow brush, wild lilac, scrub oak, squaw mat, with a little bitter brush and manzanita. The reproduction consists of nearly an equal mixture of western yellow pine, white fir and incense cedar with a scattering of sugar pine reproduction.

A very fine stand of timber occurs at the higher elevations where it has not been destroyed by fire. At the lower elevations the timber is of fair quality and appears to be growing thriftily except along the edges of the brush fields.

Past Infestation.

Probably due to adequate moisture for yellow pine growth as indicated by the percentage of fir and cedar in the stand, the old losses from insects have been negligible. Old trees on the ground indicate that such killing as has occurred has been sporadic and confined for the most

part to scattered overmature or suppressed trees. Since 1921, the surveys which have been made have always shown this unit to be in the endemic stage.

Present Infestation.

The infestation on the check section gives a good indication of what is happening on this unit. Starting with an endemic infestation of 30 trees per section in 1923, the loss continued to be endemic through 1924. In 1925, the infestation increased and 66 trees were killed per section and in 1926, 64 trees per section were killed by the summer generation alone. The infestation occurred in groups of as many as 12 trees.

Even with this increase, the infestation cannot be considered as heavy and with a winter of normal rainfall is very apt to quickly subside.

The total loss for 1926 on the 46,400 acres of this unit will probably reach 5 million board feet or approximately 1% of the stand.

HOT SPRINGS UNIT.

Description.

This unit takes in a block of timber within the boundary of the Modoc National Forest but at present protected by the organizations of the Shasta National Forest. It lies on a bench of lava in the Pit River Valley some thousand feet below the rest of the Lava Bed area and separated from it by the barren brush fields of the south slopes of the Big Valley Mountains.

The unit represents an entirely different type of forest and the infestation is in no way connected or related to that on the rest of the area. Unless there is some special reason why it should be considered, it is recommended that it be dropped in future surveys of the Lava Bed area.

The timber is short and of poor quality and is mixed with a heavy stand of brush consisting of scrub oak, mountain mahogany, manzanita, buck brush, squaw mat, and some yellow pine reproduction.

Past Infestation.

Many snags in various stages of decay indicate that the beetles have been active in this unit for many years, and have killed a high percentage of the mature and decadent trees.

Present Infestation.

Due to the poor growth conditions and insufficient moisture, the beetles at present are very active in this unit and are killing trees in large groups. In general the year's loss will run as high as 250 trees killed per section, and will average 2.5% of the stand for the unit as a whole.

CAUSES OF EPIDEMIC CONDITIONS.

Barkbeetles are the direct agency responsible for the death of the pines on this area. Of these the western pine beetle is doing the greatest amount of damage, with the pine flathead borer and the mountain pine beetle taking second and third place respectively. On certain portions of the area a small number of trees, not over 1% of the total loss, are dying from causes other than insect attack. While the causes were not definitely determined it appeared that these trees were dying from drought alone.

While barkbeetles are the direct and final cause of the death of 99% of the dead timber, there are other underlying conditions which favor beetle activity and furnish an abundance of susceptible host material and thus may be considered as responsible for the epidemic conditions. Of these the most important are (1) insufficient moisture for normal tree growth; (2) weakness of the host tree due to old age, fire, disease, or mechanical injury.

In the pine region of northern California and southern Oregon, moisture is one of the limiting factors in tree growth. Studies made by the writer through the measurement of thousands of increment cores from the southern Oregon, - northern California region have shown that the beetles select the slow growing trees - those which have suffered from moisture competition with their neighbors. Strip counts on this area also show that the beetle losses are heaviest in soils of low water holding capacity; at the lower elevations where the winter snowfall is light; and in crowded stands and on areas where reproduction and brush take a large part of the moisture.

The recent dry season in limiting the available moisture for tree growth have also been an important factor in the present epidemic.

Old, slow-growing trees offer favorable breeding material for the barkbeetles. The pine stands of this area include a high percentage of mature and decadent trees. There is considerable doubt as to whether such trees can be protected from beetle destruction in stands where they enter into critical competition with younger growth.

On certain portions of the area recent fires have produced a quantity of susceptible host material and thousands of fire weakened trees have succumbed to beetle attacks.

These conditions coupled with long open summer seasons, which have enabled the beetles to complete three generations annually, have undoubtedly been responsible for the heavy increase in beetle activity since 1923.

Recommendations.

There are three courses of action open to the owners in dealing with the insect situation on this area.

(1) To allow the beetles to continue their activities and trust to nature to bring about a final adjustment.

(2) To log the area and salvage the recent beetle killed timber as well as the green timber which is apt to be killed, and

(3) To inaugurate artificial control work and destroy the infesting beetle broods.

If the first course is adopted, and the beetles allowed to continue their activity, the chances are that a natural adjustment and temporary reduction of the losses will come about before long. This has been the history of previous epidemics, and there are indications now that the present infestation represents a peak and is more apt to decline than to make further increases.

Logging the area and salvaging the mature and beetle killed timber will without doubt settle the beetle problems for many years to come. The history of certain areas in southern Oregon indicate that even a partial thinning of the stand should be of benefit.

Control Work.

Control work can only be advocated under a permanent system of suppression on limited areas of high stumpage value. Such work should be vigorously prosecuted at the beginning of an epidemic or during an increase in infestation. Under such conditions the greatest saving in timber can be secured. After an epidemic has reached a peak, control work will reduce the losses perhaps a little faster than the natural factors alone are able to do but in many cases, the work is of doubtful benefit.

In 1923, the writer recommended that control work be undertaken on six units of this area which at that time were suffering a loss valued at $92,260 (at $3.00 per M.B.M.) The cost of the control would have been $69,250.

If this work had been carried out, it is reasonable to assume that as effective results would have been secured as from similiar work on the adjacent southern Oregon - northern California project. On this project the control work directed against the 1924 infestation not only prevemted an increase in 1925 but on certain intensively worked areas even brought about a reduction. If the work on the Modoc area had done no more than prevent an increase it would have saved $69,660 worth of timber in 1925 (enough to pay for the work) and $226,170 worth of timber in 1926).

At the present time, the indications are that the infestation on this area has reached a peak. To treat the same units as were recommended for treatment in 1922 would now cost $238,815.00

Control work at the present time would not only be tremendously expensive but would have less chance of being profitable, since a readjustment and natural reduction of losses is quite apt to occur. It is much the same as waiting to control a forest fire until it has reached its greatest size and is soon to burn itself out for lack of additional material. Under present conditions the attempting of artificial control cannot be strongly recommended.

Conditions under which artificial control methods against the western pine beetle are warranted:

1. When an increase in beetle losses is occurring or is imminent.
2. When the threatened timber is worth per thousand more than the per thousand cost of control (about $4.50 per M.B.M.)
3. When it is impractical to reduce the losses through selective logging or other forms of utilization.
4. When control can be applied over a large enough area to give effective results (20,000 to 30,000 acres).

Conditions under which artificial control methods against the western pine beetle are not warranted.

1. When the beetle losses have become acutely epidemic; are naturally declining or are endemic.
2. When the infested timber is not worth the cost of applying control measures (usually under $4.50 per M.B.M.)
3. When the infestation can be removed through selective logging operations and the infested timber thus salvaged.
4. When the cooperation of all owners of an infested tract cannot be secured, thus rendering effective work impossible.

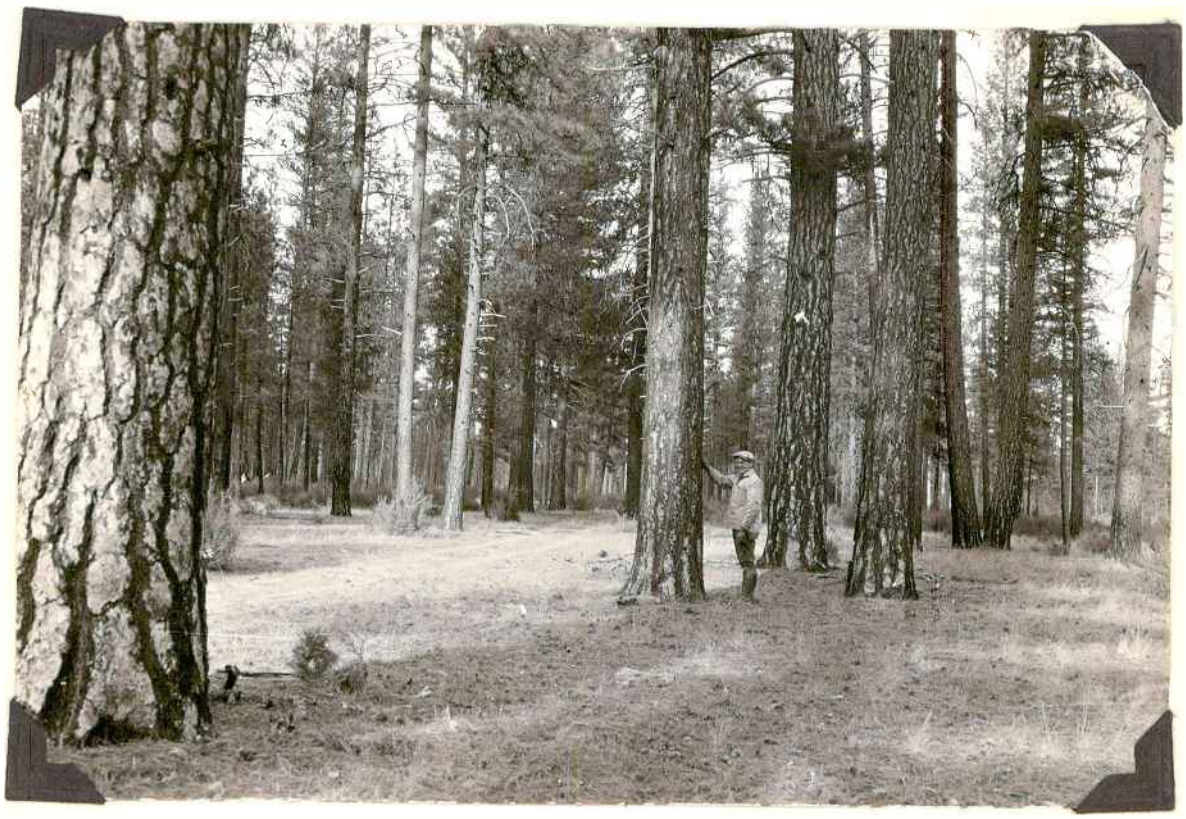

Fig. 1 - Glass Mountain Unit (Southern portion). Open timber stand on pumice soils with light ground cover of bitter brush. Infestation is very light in this part of the unit.

Fig. 2 - Happy Camp Unit (Egg Lake District). Timber with a dense understory of yellow pine reproduction. Large group of beetle-killed trees in the background. Infestation is very heavy throughout this region.

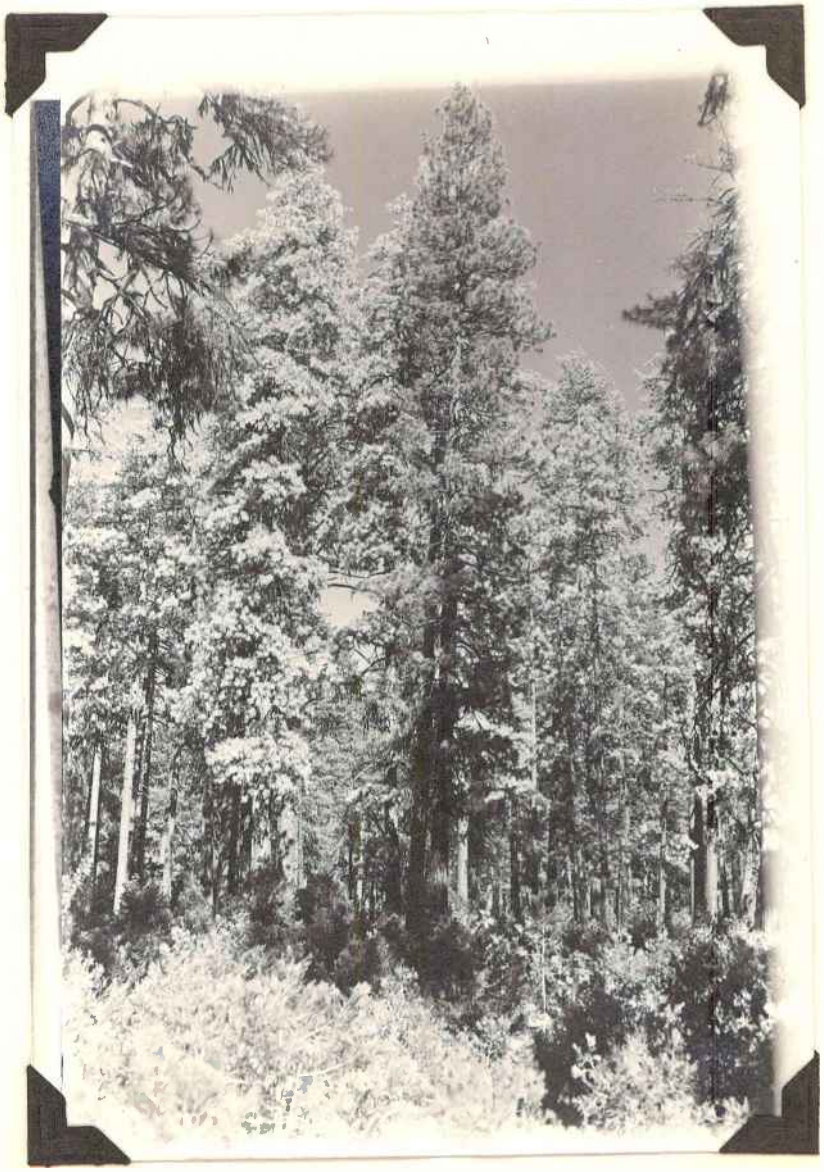

Fig. 3 - Happy Camp Unit. Groups of from 20 to 40 mature trees killed by beetles during the summer of 1926 are common throughout this unit. Note the heavy stand of reproduction beneath these trees.

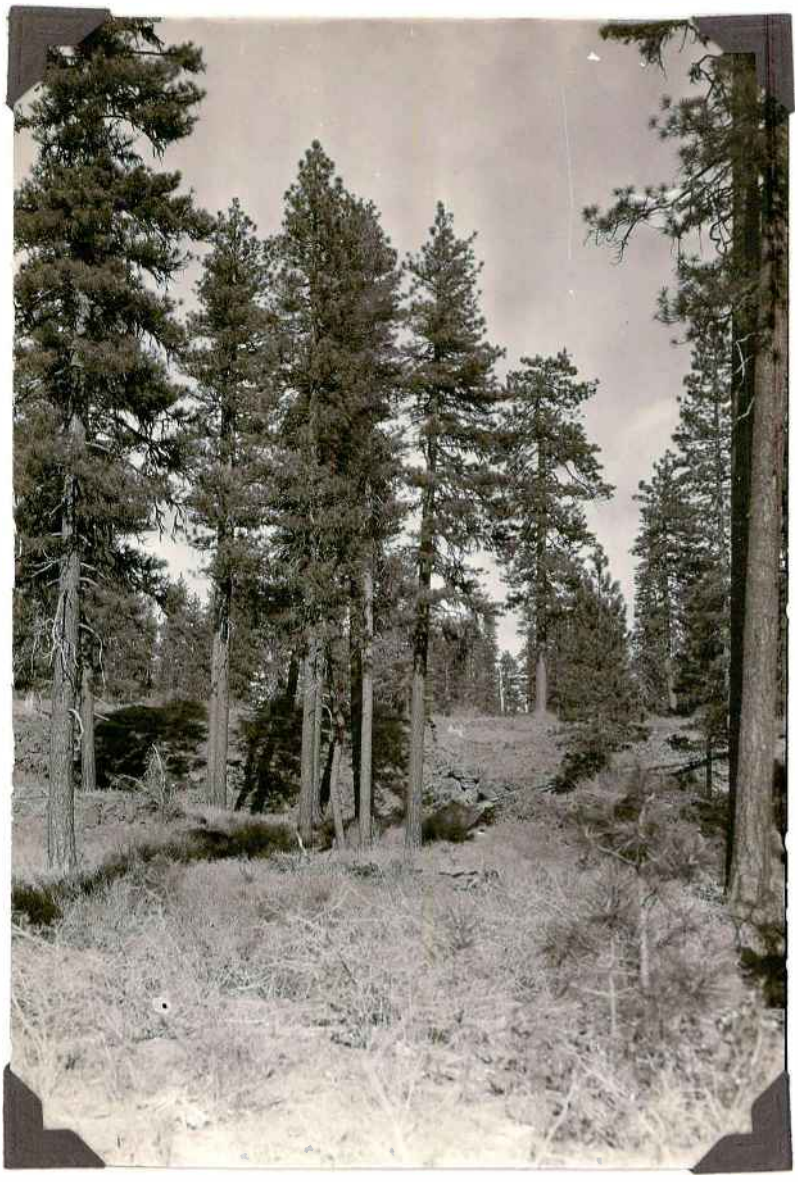

Fig. 4 - Lava Bed Unit. The scattered stand on this unit is found in soil pockets between the lava reefs, where the trees secure ample moisture, and grow thriftily. The beetle loss through this unit is very light as contrasted with other units of the area.

Fig. 5 - Lava Bed Unit. Another view of the open timber stand found on this unit. Note the light ground cover.

Fig. 6 - Pit River Unit. The scattering stands of pine at the lower elevations of this unit are characterized by slow growth and heavy infestation.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
W. B. GREELEY, FORESTER

MODOC NATIONAL FOREST
CALIFORNIA
MT. DIABLO MERIDIAN
1925

Scale
1 ½ 0 1 2 3 4 5 Miles

LEGEND

- National Forest Boundary
- Adjacent National Forest Boundary
- Good motor roads
- Poor motor roads
- Trail
- Railroad
- Supervisor's headquarters
- Ranger station
- Triangulation station
- House, cabin, or other building
- Main motor highways

R. 14½ E. 8th. | R. 15 E. | R. 16 E. Standard | R. 17 E.

T. 40 S. | T. 41 S. | T. 48 N. | T. 47 N. | T. 46 N. | T. 45 N. | T. 44 N. | T. 43 N. | T. 42 N. | T. 41 N. | T. 40 N. | T. 39 N. | T. 38 N. | T. 37 N. | T. 36 N.

42° 00′ | 50′ | 40′ | 41° 30′ | 20′ | 10′ | 41° 00′

R. 5 E. | R. 6 E. | R. 7 E.

TO MERRILL & KLAMATH FALLS | OLD SHORE LINE | TO KLAMATH FALLS | TO LANGELL VALLEY

OREGON | CALIFORNIA

MERRILL LAND'S | CHALK BANK LAND'S | TO DORRIS | TO MEDICINE LAKE | TO MC CLOUD | TO REDDING | TO MT. SHASTA CITY

Lower Klamath Lake | TULE LAKE | FLOW LINE | Bloody Point | B.M. 4067 | 5576

CLEAR LAKE RESERVOIR | CLEAR LAKE DAM | Carr Ranch | Bird I. | 4523 | Cornell Bald Mt. 5750 | Dome Mt. | Crater Mt. | Hospital Rock | CAPT. JACKS STRONGHOLD | GUILLEMS GRAVE | CANBY CROSS | CHIMNEYS | BATTLE GROUND MODOC INDIAN WAR 1873

Rock Creek | Lost River | East Branch Lost River | North Fork Lost River | Spring | Willow Cr. | Mammoth Springs | Steele Meadow | Steele Swamp | Becraft Ranch | Baldy (Dog Mt. G.S.) | Herriford Ranch | Yocum | F. Grons | Fourmile Spg. | Weed Valley | Keyhole Mt. | Janes Flat Spg. | Homestead Well | Turner Trough | Blue Flat | Crowder R.S. | Janes Flat Res. | Bird Spg. | Tramp Spg. | Huffman | Fletcher Cr. | Quacking Asp Spg. | Blue Mt. Lookout | Pot Hole Spring | Pot Hole Valley | Hager Basin | Standard | Double Head 5537 | Schonchin Butte | CAVE | INDIAN WELL | ICE CAVE | CAVES | CALDWELL ICE CAVES | Callahan Spr. | Spg. | Mt. Hoffman (G.S.) | Glass Mt. 7852 | 6320 | Payne Spg. | Straw | Dry Pond | Mowitz Cr. Reservoir | Mowitz Butte 5300 Apx. | Lone Pine Butte | Reservoir | Surveyor's Valley | Round Valley | Triangle | Williams Valley | L. and M. Reservoir | Graves Valley | Antelope Plains | Boles Meadow | L. and M. Reservoir | Spring | Coyote Spg. | Boles Spg. R.S. | Timbered Mt. 6505 | Badger Spg. & Corral | Duncan Horse Camp | Deer Hill | Badger Spgs Unit | Lost Valley | Fairchild Swamp | Big Sage Reservoir | Mill Spring | Widow Valley | Log House | Bucher Swamp | Jack's Swamp | Dobe Swale | Essex Spg. | Essex Reservoir | Salisbury | Rail Mt. | Williams Reservoir | Hog L. | Jaquima Reservoir | Duncan Reservoir | Shaw Springs Reservoir | Mud Lake | Mud Spg. | Pit River Unit | Lava Lake | Water | Water Hole | Water Holes | Round Mt. | Buck Butte | Crater | Timbered Crater | Hot Spgs Unit | Big Valley Mt. Unit | Big Valley Mountains | Sugar Pine Ridge | Hole in Rock | Indian Spg. | Mayfield Spg. | Egg Lake | White Horse Unit | White Horse Res. | Kramer Res. | White Horse Valley | Little Hot Spg. | Little Hot Spring Valley | Day | Lookout | Happy Camp Unit | Happy Camp Lookout | Grouse Spg. | Turner Cr. | Casen Spg. | Crank Spg. | Stone Coal Valley | Rattlesnake Butte 5860 | Lorenz | Mitchell | Andrews | Roberts Res. | DUTCH FLAT R.S. | HAPPY CAMP R.S. | PIT RIVER R.S. | CANBY WARM SPRINGS VALLEY | Rattlesnake Butte | Schaffer Mt. | Ballard Mill | Reservoir | Dry Reservoir | Canyon Creek | Swale | Cottonwood Flat | Sweagert Flat | Adin | Dana | Pond | Tule L. | Abandoned Tule Farm Project | Military Reservation | Glenburn | McArthur | McArthur (G.S. Unpub.) | BRIDGE | Pittville | Pittville (G.S. Unpub.) | W.A. Vestal | T.H. Vestal | Burton | Hot Spg. | Spring | Saddle | Upper Tree (G.S. Unpub.) | Fall River (G.S.) | Fall River Mills | Snell (G.S. Unpub.) | Muck Valley | B.M. 4146 | B.M. 3946 | Carbon | Hoosan | Wes Brown | Baum | Conrad L. | Caves | Smith | Barton Ranch | Beaver Cr. | Pit R. | Timber Mt. | Timber Mt. Unit | Glass Mt Unit | Deer Hill | Payne Spg. | Little Hot Spg. | Day | Water | Valley | Summit | Lava Bed Unit | Lava Bed Flow | Modoc Co. | Siskiyou Co. | Shasta Co. | Lassen Co. | Modoc - Lava Bed Project. | Pine Beetle Loss of 1926 | Legend. | Unit Boundaries | Percent of Stand Killed in 1926 | Less than 1 % | Between 1% - 2% | " 2% - 3% | " 3% - 4% | Over 4% | October 1926